A simple mechanism for rotation reversal in ohmic L modes

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TOPIC: C) **Momentum and particle/impurity transport, and impact of rotation on transport**

Rotation of L-mode plasmas is a complex issue, with many different effects having been observed. In general the L-mode rotation behaviour, unless there is a strong external source of momentum, is far less well understood than the rotation of H-mode discharges. H-mode rotation seems to be more robust, either because the H-mode is usually achieved at high heating power including external momentum input by beams or due to high rotation at the pedestal, which allows for a robust boundary condition for the rotation.
For plasmas with no obvious external momentum source spontaneous spin up poses a problem to transport theory as without initial rotation velocity or seed flow the momentum flux is zero everywhere and so no build-up of rotation, neither of net plasma rotation or of differential plasma rotation can take place.
While the most prominent source of plasma toroidal momentum is the tangential injection of neutral beams, there are several effects which allow for momentum input from the edge. None of these mechanism can so far explain the observed rapid transition from co to counter-rotation observed in Alcator C Mod and other devices when the edge density is increased in ohmic L-mode plasmas.

It has been suggested that turbulent momentum transport can lead to differential transport of positive and negative momentum fluctuations, thus leading to a differential rotation source, which can lead to spin up. This local momentum flux, which is generated in the plasma itself, cannot be expressed in terms of a transport term as it is neither proportional to the gradient of the velocity profile, e.g. to be expressed as a diffusion like term, nor to the velocity itself, e.g. a convective or pinch velocity like term. Its appearance in a transport equation is like a localised source.
Several experiments have tried to measure this effect, but it is notoriously difficult to separate from other sources of momentum and moreover only during spin up and spin down of the plasma it leads to measurable momentum fluxes out of the plasma. This Residual Stress exerts a zero net torque on the plasma but can create nonzero momentum fluxes. It is usually not captured by transport models. We here demonstrate in a simple transport model how RS can lead to rotation reversal.

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